

REPORT DOCUMENTATION PAGE

Form Approved
OPM No. 0704-0188

Public rep
needed, a
Headquarter
Manager
1. AGEN

AD-A238 317



response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Information and Regulatory Affairs, Office of

ATE

3. REPORT TYPE AND DATES COVERED

Final: 09 Jan 1991 to 01 March 1993

4. TITLE AND SUBTITLE

Tartan Inc., Tartan Ada VMS/1750A, Version 4.0, VAXstation 3200 (Host) to Texas Instruments STL(Target), 901213I1.11119

6. AUTHOR(S)

IABG-AVF
Ottobrunn, Federal Republic of Germany

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

IABG-AVF, Industrieanlagen-Betriebsgesellschaft
Dept. SZT/ Einsteinstrasse 20
D-8012 Ottobrunn
FEDERAL REPUBLIC OF GERMANY

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Ada Joint Program Office
United States Department of Defense
Pentagon, Rm 3E114
Washington, D.C. 20301-3021

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution unlimited.

8. PERFORMING ORGANIZATION REPORT NUMBER

IABG-VSR 078

13. ABSTRACT (Maximum 200 words)

Tartan Inc., Tartan Ada VMS/1750A, Version 4.0, Ottobrunn, Germany, VAXstation 3200 (Host) to Texas Instruments STL (Target). ACVC 1.11.

12b. DISTRIBUTION CODE

91-03864



14. SUBJECT TERMS

Ada programming language, Ada Compiler Val. Summary Report, Ada Compiler Val. Capability, Val. Testing, Ada Val. Office, Ada Val. Facility, ANSI/MIL-STD-1815A, AJPO.

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION
OF REPORT
UNCLASSIFIED

18. SECURITY CLASSIFICATION
UNCLASSIFIED

19. SECURITY CLASSIFICATION
OF ABSTRACT
UNCLASSIFIED

20. LIMITATION OF ABSTRACT

Certificate Information

The following Ada implementation was tested and determined to pass ACVC 1.11. Testing was completed on December 13, 1990.

Compiler Name and Version: Tartan Ada VMS/1750A Version 4.0

Host Computer System: VAXstation 3200 VMS 5.2

Target Computer System: Texas Instruments STL VHSIC 1750A

See Section 3.1 for any additional information about the testing environment.

As a result of this validation effort, Validation Certificate 901213II.11119 is awarded to Tartan Inc. This certificate expires on 1 March, 1993.

This report has been reviewed and is approved.

Michael Tonndorf
IABG, Abt. ITE
Michael Tonndorf
Einsteinstr. 20
W-8012 Ottobrunn
Germany

John P. Solomond
Ada Validation Organization
Director, Computer & Software Engineering Division
Institute for Defense Analyses
Alexandria VA 22311

John P. Solomond
Ada Joint Program Office
Dr. John Solomond, Director
Department of Defense
Washington DC 20301



Accession No.	
STIS GRAB	
DTIC TAB	
Unannounced	
Justification	
By	
Distribution/	
Availability Codes	
Avail and/or	
Dist	Special
A-1	

AVF Control Number: IABG-VSR 078
9 January, 1991

== based on TEMPLATE Version 90-08-15 ==

Ada COMPILER
VALIDATION SUMMARY REPORT:
Certificate Number: 901213I1.11119
Tartan Inc.
Tartan Ada VMS/1750A Version 4.0
VAXstation 3200 => Texas Instruments STL
VMS 5.2 VHSIC 1750A

Prepared By:
IABG, ABT. ITE

DECLARATION OF CONFORMANCE

Customer: Tartan, Inc.

Certificate Awardee: Tartan, Inc.

Ada Validation Facility: IABG

ACVC Version: 1.11

Ada Implementation:

Ada Compiler Name and Version: Tartan Ada VMS/1750A Version 4.0

Host Compiler System: VAXstation 3200 VMS 5.2

Target Computer System: Texas Instruments STL VHSIC 1750A

Declaration:

[I/we] the undersigned, declare that [I/we] have no knowledge of deliberate deviations from the Ada Language Standard ANSI/MIL-STD-1815A ISO 8652-1987 in the implementation listed above.



Customer Signature

Date: 12/14/90

TABLE OF CONTENTS

CHAPTER 1	INTRODUCTION
1.1	USE OF THIS VALIDATION SUMMARY REPORT 1-1
1.2	REFERENCES 1-2
1.3	ATVC TEST CLASSES 1-2
1.4	DEFINITION OF TERMS 1-3
CHAPTER 2	IMPLEMENTATION DEPENDENCIES
2.1	WITHDRAWN TESTS 2-1
2.2	INAPPLICABLE TESTS 2-1
2.3	TEST MODIFICATIONS 2-4
CHAPTER 3	PROCESSING INFORMATION
3.1	TESTING ENVIRONMENT 3-1
3.2	SUMMARY OF TEST RESULTS 3-1
3.3	TEST EXECUTION 3-2
APPENDIX A	MACRO PARAMETERS
APPENDIX B	COMPILEATION SYSTEM OPTIONS
APPENDIX C	APPENDIX F OF THE Ada STANDARD

CHAPTER 1

INTRODUCTION

The Ada implementation described above was tested according to the Ada Validation Procedures [Pro90] against the Ada Standard [Ada83] using the current Ada Compiler Validation Capability (ACVC). This Validation Summary Report (VSR) gives an account of the testing of this Ada implementation. For any technical terms used in this report, the reader is referred to [Pro90]. A detailed description of the ACVC may be found in the current ACVC User's Guide [UG89].

1.1 USE OF THIS VALIDATION SUMMARY REPORT

Consistent with the national laws of the originating country, the Ada Certification Body may make full and free public disclosure of this report. In the United States, this is provided in accordance with the "Freedom of Information Act" (5 U.S.C. #552). The results of this validation apply only to the computers, operating systems, and compiler versions identified in this report.

The organizations represented on the signature page of this report do not represent or warrant that all statements set forth in this report are accurate and complete, or that the subject implementation has no nonconformities to the Ada Standard other than those presented. Copies of this report are available to the public from the AVF which performed this validation or from:

National Technical Information Service
5285 Port Royal Road
Springfield VA 22161

Questions regarding this report or the validation test results should be directed to the AVF which performed this validation or to:

Ada Validation Organization
Institute for Defense Analyses
1301 North Beauregard Street
Alexandria VA 22311

1.2 REFERENCES

[Ada83] Reference Manual for the Ada Programming Language,
ANSI/MIL-STD-1815A, February 1983 and ISO 8652-1987.

[Pro90] Ada Compiler Validation Procedures, Version 2.1, Ada Joint
Program Office, August 1990.

[UG89] Ada Compiler Validation Capability User's Guide, 21 June 1989.

1.3 ACVC TEST CLASSES

Compliance of Ada implementations is tested by means of the ACVC. The ACVC contains a collection of test programs structured into six test classes: A, B, C, D, E, and L. The first letter of a test name identifies the class to which it belongs. Class A, C, D, and E tests are executable. Class B and class L tests are expected to produce errors at compile time and link time, respectively.

The executable tests are written in a self-checking manner and produce a PASSED, FAILED, or NOT APPLICABLE message indicating the result when they are executed. Three Ada library units, the packages REPORT and SPPRT13, and the procedure CHECK_FILE are used for this purpose. The package REPORT also provides a set of identity functions used to defeat some compiler optimizations allowed by the Ada Standard that would circumvent a test objective. The package SPPRT13 is used by many tests for Chapter 13 of the Ada Standard. The procedure CHECK_FILE is used to check the contents of text files written by some of the Class C tests for Chapter 14 of the Ada Standard. The operation of REPORT and CHECK_FILE is checked by a set of executable tests. If these units are not operating correctly, validation testing is discontinued.

Class B tests check that a compiler detects illegal language usage. Class B tests are not executable. Each test in this class is compiled and the resulting compilation listing is examined to verify that all violations of the Ada Standard are detected. Some of the class B tests contain legal Ada code which must not be flagged illegal by the compiler. This behavior is also verified.

Class L tests check that an Ada implementation correctly detects violation of the Ada Standard involving multiple, separately compiled units. Errors are expected at link time, and execution is attempted.

In some tests of the ACVC, certain macro strings have to be replaced by implementation-specific values -- for example, the largest integer. A list of the values used for this implementation is provided in Appendix A. In addition to these anticipated test modifications, additional changes may be required to remove unforeseen conflicts between the tests and implementation-dependent characteristics. The modifications required for this implementation are described in Section 2.3.

For each Ada implementation, a customized test suite is produced by the AVF. This customization consists of making the modifications described in the preceding paragraph, removing withdrawn tests (see Section 2.1) and, possibly some inapplicable tests (see Section 2.2 and [UG89]).

In order to pass an ACVC an Ada implementation must process each test of the customized test suite according to the Ada Standard.

1.4 DEFINITION OF TERMS

Ada Compiler	The software and any needed hardware that have to be added to a given host and target computer system to allow transformation of Ada programs into executable form and execution thereof.
Ada Compiler Validation Capability (ACVC)	The means for testing compliance of Ada implementations, consisting of the test suite, the support programs, the ACVC user's guide and the template for the validation summary report.
Ada Implementation	An Ada compiler with its host computer system and its target computer system.
Ada Validation Facility (AVF)	The part of the certification body which carries out the procedures required to establish the compliance of an Ada implementation.
Ada Validation Organization (AVO)	The part of the certification body that provides technical guidance for operations of the Ada certification system.
Compliance of an Ada Implementation	The ability of the implementation to pass an ACVC version.
Computer System	A functional unit, consisting of one or more computers and associated software, that uses common storage for all or part of a program and also for all or part of the data necessary for the execution of the program; executes user-written or user-designated programs; performs user-designated data manipulation, including arithmetic operations and logic operations; and that can execute programs that modify themselves during execution. A computer system may be a stand-alone unit or may consist of several inter-connected units.
Conformity	Fulfillment by a product, process or service of all requirements specified.

Customer	An individual or corporate entity who enters into an agreement with an AVF which specifies the terms and conditions for services (of any kind) to be performed.
Declaration of Conformance	A formal statement from a customer assuring that conformity is realized or attainable on the Ada implementation for which validation status is realized.
Host Computer System	A computer system where Ada source programs are transformed into executable form.
Inapplicable test	A test that contains one or more test objectives found to be irrelevant for the given Ada implementation.
Operating System	Software that controls the execution of programs and that provides services such as resource allocation, scheduling, input/output control, and data management. Usually, operating systems are predominantly software, but partial or complete hardware implementations are possible.
Target Computer System	A computer system where the executable form of Ada programs are executed.
Validated Ada Compiler	The compiler of a validated Ada implementation.
Validated Ada Implementation	An Ada implementation that has been validated successfully either by AVF testing or by registration [Pro90].
Validation	The process of checking the conformity of an Ada compiler to the Ada programming language and of issuing a certificate for this implementation.
Withdrawn test	A test found to be incorrect and not used in conformity testing. A test may be incorrect because it has an invalid test objective, fails to meet its test objective, or contains erroneous or illegal use of the Ada programming language.

CHAPTER 2
IMPLEMENTATION DEPENDENCIES

2.1 WITHDRAWN TESTS

The following tests have been withdrawn by the AVO. The rationale for withdrawing each test is available from either the AVO or the AVF. The publication date for this list of withdrawn tests is November 21, 1990.

E28005C	B28006C	C34006D	C35702A	B41308B	C43004A
C45114A	C45346A	C45612B	C45651A	C46022A	B49008A
A74006A	C74308A	B83022B	B83022H	B83025B	B83025D
B83026B	B85001L	C83026A	C83041A	C97116A	C98003B
BA2011A	CB7001A	CB7001B	CB7004A	CC1223A	BC1226A
CC1226B	BC3009B	AD1B08A	BD1B02B	BD1B06A	BD2A02A
CD2A21E	CD2A23E	CD2A32A	CD2A41A	CD2A41E	CD2A87A
CD2B15C	BD3006A	BD4008A	CD4022A	CD4022D	CD4024B
CD4024C	CD4024D	CD4031A	CD4051D	CD5111A	CD7004C
ED7005D	CD7005E	AD7006A	CD7006E	AD7201A	AD7201E
CD7204B	BD8002A	BD8004C	CD9005A	CD9005B	CDA201E
CE2107I	CE2117A	CE2117B	CE2119B	CE2205B	CE2405A
CE3111C	CE3116A	CE3118A	CE3411B	CE3412B	CE3607B
CE3607C	CE3607D	CE3812A	CE3814A	CE3902B	

2.2 INAPPLICABLE TESTS

A test is inapplicable if it contains test objectives which are irrelevant for a given Ada implementation. Reasons for a test's inapplicability may be supported by documents issued by ISO and the AJPO known as Ada Commentaries and commonly referenced in the format AI-ddddd. For this implementation, the following tests were determined to be inapplicable for the reasons indicated; references to Ada Commentaries are included as appropriate.

IMPLEMENTATION DEPENDENCIES

The following 285 tests have floating-point type declarations requiring more digits than `SYSTEM.MAX_DIGITS`:

C24113F..Y (20 tests)	C35705F..Y (20 tests)
C35706F..Y (20 tests)	C35707F..Y (20 tests)
C35708F..Y (20 tests)	C35802F..Z (21 tests)
C45241F..Y (20 tests)	C45321F..Y (20 tests)
C45421F..Y (20 tests)	C45521F..Z (21 tests)
C45524F..Z (21 tests)	C45621F..Z (21 tests)
C45641F..Y (20 tests)	C46012F..Z (21 tests)

The following 21 tests check for the predefined type `SHORT_INTEGER`:

C35404B	B36105C	C45231B	C45304B	C45411B
C45412B	C45502B	C45503B	C45504B	C45504E
C45611B	C45613B	C45614B	C45631B	C45632B
B52004E	C55B07B	B55B09D	B86001V	C86006D
CD7101E				

`C35404D`, `C45231D`, `B86001X`, `C86006E`, and `CD7101G` check for a predefined integer type with a name other than `INTEGER`, `LONG_INTEGER`, or `SHORT_INTEGER`.

`C35713B`, `C45423B`, `B86001T`, and `C86006H` check for the predefined type `SHORT_FLOAT`.

`C35713D` and `B86001Z` check for a predefined floating-point type with a name other than `FLOAT`, `LONG_FLOAT`, or `SHORT_FLOAT`.

`A35801E` checks that `FLOAT'FIRST..FLOAT'LAST` may be used as a range constraint in a floating-point type declaration; for this implementation, that range exceeds the range of safe numbers of the largest predefined floating-point type and must be rejected. (see 2.3.)

`C45531M..P` (4 tests) and `C45532M..P` (4 tests) check fixed-point operations for types that require a `SYSTEM.MAX_MANTISSA` of 47 or greater; for this implementation, there is no such type.

`C45536A`, `C46013B`, `C46031B`, `C46033B`, and `C46034B` contain '`SMALL`' representation clauses which are not powers of two or ten.

`C45624A` and `C45624B` are not applicable as `MACHINE_OVERFLOW` is `TRUE` for floating-point types.

`D64005G` is inapplicable because this implementation does not support nesting 17 levels of recursive procedure calls.

`B86001Y` checks for a predefined fixed-point type other than `DURATION`.

`CD1009C` uses a representation clause specifying a non-default size for a floating-point type.

IMPLEMENTATION DEPENDENCIES

CA2009A, CA2009C..D (2 tests), CA2009F and BC3009C instantiate generic units before their bodies are compiled; this implementation creates a dependence on generic units as allowed by AI-00408 & AI-00506 such that the compilation of the generic unit bodies makes the instantiating units obsolete. (see 2.3.)

CD2A53A checks operations of a fixed-point type for which a length clause specifies a power-of-ten type'small; this implementation does not support decimal smalls. (see 2.3.)

CD2A84A, CD2A84E, CD2A84I..J (2 tests), and CD2A840 use representation clauses specifying non-default sizes for access types.

CD2B15B checks that `STORAGE_ERROR` is raised when the storage size specified for a collection is too small to hold a single value of the designated type; this implementation allocates more space than what the length clause specified, as allowed by AI-00558.

The following 264 tests check for sequential, text, and direct access files:

CE2102A..C (3)	CE2102G..H (2)	CE2102K	CE2102N..Y (12)
CE2103C..D (2)	CE2104A..D (4)	CE2105A..B (2)	CE2106A..B (2)
CE2107A..H (8)	CE2107L	CE2108A..H (8)	CE2109A..C (3)
CE2110A..D (4)	CE2111A..I (9)	CE2115A..B (2)	CE2120A..B (2)
CE2201A..C (3)	EE2201D..E (2)	CE2201F..N (9)	CE2203A
CE2204A..D (4)	CE2205A	CE2206A	CE2208B
CE2401A..C (3)	EE2401D	CE2401E..F (2)	EE2401G
CE2401H..L (5)	CE2403A	CE2404A..B (2)	CE2405B
CE2406A	CE2407A..B (2)	CE2408A..B (2)	CE2409A..B (2)
CE2410A..B (2)	CE2411A	CE3102A..C (3)	CE3102F..H (3)
CE3102J..K (2)	CE3103A	CE3104A..C (3)	CE3106A..B (2)
CE3107B	CE3108A..B (2)	CE3109A	CE3110A
CE3111A..B (2)	CE3111D..E (2)	CE3112A..D (4)	CE3114A..B (2)
CE3115A	CE3119A	EE3203A	EE3204A
CE3207A	CE3208A	CE3301A	EE3301B
CE3302A	CE3304A	CE3305A	CE3401A
CE3402A	EE3402B	CE3402C..D (2)	CE3403A..C (3)
CE3403E..F (2)	CE3404B..D (3)	CE3405A	EE3405B
CE3405C..D (2)	CE3406A..D (4)	CE3407A..C (3)	CE3408A..C (3)
CE3409A	CE3409C..E (3)	EE3409F	CE3410A
CE3410C..E (3)	EE3410F	CE3411A	CE3411C
CE3412A	EE3412C	CE3413A..C (3)	CE3414A
CE3602A..D (4)	CE3603A	CE3604A..B (2)	CE3605A..E (5)
CE3606A..B (2)	CE3704A..F (6)	CE3704M..O (3)	CE3705A..E (5)
CE3706D	CE3706F..G (2)	CE3804A..P (16)	CE3805A..B (2)
CE3806A..B (2)	CE3806D..E (2)	CE3806G..H (2)	CE3904A..B (2)
CE3905A..C (3)	CE3905L	CE3906A..C (3)	CE3906E..F (2)

CE2103A, CE2103B and CE3107A require `NAME_ERROR` to be raised when an attempt is made to create a file with an illegal name; this implementation does not support external files and so raises `USE_ERROR`. (see 2.3.)

2.3 TEST MODIFICATIONS

Modifications (see Section 1.3) were required for 103 tests.

The following tests were split into two or more tests because this implementation did not report the violations of the Ada Standard in the way expected by the original tests.

B22003A	B24007A	B24009A	B25002B	B32201A	B33204A
B33205A	B35701A	B36171A	B36201A	B37101A	B37102A
B37201A	B37202A	B37203A	B37302A	B38003A	B38003B
B38008A	B38008B	B38009A	B38009B	B38103A	B38103B
B38103C	B38103D	B38103E	B43202C	B44002A	B48002A
B48002B	B48002D	B48002E	B48002G	B48003E	B49003A
B49005A	B49006A	B49006B	B49007A	B49007B	B49009A
E4A010C	B54A20A	B54A25A	B58002A	B58002B	B59001A
B59001C	B59001I	B62006C	B67001A	B67001B	B67001C
B67001D	B74103E	B74104A	B74307B	B83E01A	B83E01B
B85007C	B85008G	B85008H	B91004A	B91005A	B95003A
B95007B	B95031A	B95074E	BC1002A	BC1109A	BC1109C
BC1206A	BC2001E	BC3005B	BD2A06A	BD2B03A	BD2D03A
BD4003A	BD4006A	BD8003A			

E28002B was graded inapplicable by Evaluation and Test Modification as directed by the AVO. This test checks that pragmas may have unresolvable arguments, and it includes a check that pragma LIST has the required effect; but for this implementation, pragma LIST has no effect if the compilation results in errors or warnings, which is the case when the test is processed without modification. This test was also processed with the pragmas at lines 46, 58, 70 and 71 commented out so that pragma LIST had effect.

A35801E was graded inapplicable by Evaluation Modification as directed by the AVO; the compiler rejects the use of the range FLOAT'FIRST..FLOAT'LAST as the range constraint of a floating-point type declaration because the bounds lie outside of the range of safe numbers (cf. LRM 3.5.7(12)).

Tests C45524A..E (5 tests) were graded passed by Test Modification as directed by the AVO. These tests expect that a repeated division will result in zero; but the standard only requires that the result lie in the smallest safe interval. Thus, the tests were modified to check that the result was within the smallest safe interval by adding the following code after line 141; the modified tests were passed:

```
ELSIF VAL <= F'SAFE_SMALL THEN COMMENT ("UNDERFLOW SEEMS GRADUAL");
```

C83030C and C86007A were graded passed by Test Modification as directed by the AVO. These tests were modified by inserting "PRAGMA ELABORATE (REPORT);" before the package declarations at lines 13 and 11, respectively. Without the pragma, the packages may be elaborated prior to package report's body, and thus the packages' calls to function Report.Ident_Int at lines 14 and 13, respectively, will raise PROGRAM_ERROR.

IMPLEMENTATION DEPENDENCIES

B83E01B was graded passed by Evaluation Modification as directed by the AVO. This test checks that a generic subprogram's formal parameter names (i.e. both generic and subprogram formal parameter names) must be distinct; the duplicated names within the generic declarations are marked as errors, whereas their recurrences in the subprogram bodies are marked as "optional" errors--except for the case at line 122, which is marked as an error. This implementation does not additionally flag the errors in the bodies and thus the expected error at line 122 is not flagged. The AVO ruled that the implementation's behavior was acceptable and that the test need not be split (such a split would simply duplicate the case in B83E01A at line 15).

CA2009A, CA2009C..D (2 tests), CA2009F and BC3009C were graded inapplicable by Evaluation Modification as directed by the AVO. These tests instantiate generic units before those units' bodies are compiled; this implementation creates dependences as allowed by AI-00408 & AI-00506 such that the compilation of the generic unit bodies makes the instantiating units obsolete, and the objectives of these tests cannot be met.

BC3204C and BC3205D were graded passed by Processing Modification as directed by the AVO. These tests check that instantiations of generic units with unconstrained types as generic actual parameters are illegal if the generic bodies contain uses of the types that require a constraint. However, the generic bodies are compiled after the units that contain the instantiations, and this implementation creates a dependence of the instantiating units on the generic units as allowed by AI-00408 & AI-00506 such that the compilation of the generic bodies makes the instantiating units obsolete--no errors are detected. The processing of these tests was modified by compiling the separate files in the following order (to allow re-compilation of obsolete units), and all intended errors were then detected by the compiler:

BC3204C: C0, C1, C2, C3M, C4, C5, C6, C3M

BC3205D: D0, D2, D1M

BC3204D and BC3205C were graded passed by Test Modification as directed by the AVO. These tests are similar to BC3204C and BC3205D above, except that all compilation units are contained in a single compilation. For these two tests, a copy of the main procedure (which later units make obsolete) was appended to the tests; all expected errors were then detected.

CD2A53A was graded inapplicable by Evaluation Modification as directed by the AVO. The test contains a specification of a power-of-ten value as small for a fixed-point type. The AVO ruled that, under ACVC 1.11, support of decimal smalls may be omitted.

IMPLEMENTATION DEPENDENCIES

AD9001B and AD9004A were graded passed by Processing Modification as directed by the AVO. These tests check that various subprograms may be interfaced to external routines (and hence have no Ada bodies). This implementation requires that a file specification exists for the foreign subprogram bodies. The following command was issued to the Librarian to inform it that the foreign bodies will be supplied at link time (as the bodies are not actually needed by the program, this command alone is sufficient):

```
AL17> interface/system AD9004A
```

CE2103A, CE2103B and CE3107A were graded inapplicable by Evaluation Modification as directed by the AVO. The tests abort with an unhandled exception when USE_ERROR is raised on the attempt to create an external file. This is acceptable behavior because this implementation does not support external files (cf. AI-00332).

CHAPTER 3

PROCESSING INFORMATION

3.1 TESTING ENVIRONMENT

The Ada implementation tested in this validation effort is described adequately by the information given in the initial pages of this report.

For a point of contact for technical information about this Ada implementation system, see:

Mr Ron Duursma
Director of Ada Products
Tartan Inc.
300, Oxford Drive,
Monroeville, PA 15146,
USA.
Tel. (412) 856-3600

For a point of contact for sales information about this Ada implementation system, see:

Mr Bill Geese
Director of Sales
Tartan Inc.
300, Oxford Drive,
Monroeville, PA 15146,
USA.
Tel. (412) 856-3600

Testing of this Ada implementation was conducted at the customer's site by a validation team from the AVF.

3.2 SUMMARY OF TEST RESULTS

An Ada Implementation passes a given ACVC version if it processes each test of the customized test suite in accordance with the Ada Programming Language Standard, whether the test is applicable or inapplicable; otherwise, the Ada Implementation fails the ACVC [Pro90].

PROCESSING INFORMATION

For all processed tests (inapplicable and applicable), a result was obtained that conforms to the Ada Programming Language Standard.

a) Total Number of Applicable Tests	3472
b) Total Number of Withdrawn Tests	83
c) Processed Inapplicable Tests	66
d) Non-Processed I/O Tests	264
e) Non-Processed Floating-Point Precision Tests	285
f) Total Number of Inapplicable Tests	615 (c+d+e)
g) Total Number of Tests for ACVC 1.11	4170 (a+b+f)

The above number of I/O tests were not processed because this implementation does not support a file system. The above number of floating-point tests were not processed because they used floating-point precision exceeding that supported by the implementation. When this compiler was tested, the tests listed in Section 2.1 had been withdrawn because of test errors.

3.3 TEST EXECUTION

Version 1.11 of the ACVC comprises 4170 tests. When this compiler was tested, the tests listed in Section 2.1 had been withdrawn because of test errors. The AVF determined that 615 tests were inapplicable to this implementation. All inapplicable tests were processed during validation testing except for 285 executable tests that use floating-point precision exceeding that supported by the implementation and 264 executable tests that use file operations not supported by the implementation. In addition, the modified tests mentioned in Section 2.3 were also processed.

A Magnetic Tape Reel containing the customized test suite (see Section 1.3) was taken on-site by the validation team for processing. The contents of the tape were loaded directly onto the host computer.

After the test files were loaded onto the host computer, the full set of tests was processed by the Ada implementation.

The tests were compiled and linked on the host computer system, as appropriate. The executable images were transferred to the target computer system by the communications link, an RS232 interface, and run. The results were captured on the host computer system.

Testing was performed using command scripts provided by the customer and reviewed by the validation team. See Appendix B for a complete listing of the processing options for this implementation. It also indicates the default options. The options invoked explicitly for validation testing during this test were:

PROCESSING INFORMATION

options used for compiling:

/replace forces the compiler to accept an attempt to compile a unit imported from another library which is normally prohibited.

/nosave_source suppresses the creation of a registered copy of the source code in the library directory for use by the REMAKE and MAKE subcommands.

/list=always forces a listing to be produced, default is to only produce a listing when an error occurs.

No explicit Linker options were used.

Test output, compiler and linker listings, and job logs were captured on Magnetic Tape Reel and archived at the AVF. The listings examined on-site by the validation team were also archived.

APPENDIX A
MACRO PARAMETERS

This appendix contains the macro parameters used for customizing the ACVC. The meaning and purpose of these parameters are explained in [UG89]. The parameter values are presented in two tables. The first table lists the values that are defined in terms of the maximum input-line length, which is the value for \$MAX_IN_LEN--also listed here. These values are expressed here as Ada string aggregates, where "V" represents the maximum input-line length.

Macro Parameter	Macro Value
\$BTG_ID1	(1..V-1 => 'A', V => '1')
\$BIG_ID2	(1..V-1 => 'A', V => '2')
\$BIG_ID3	(1..V/2 => 'A') & '3' & (1..V-1-V/2 => 'A')
\$BIG_ID4	(1..V/2 => 'A') & '4' & (1..V-1-V/2 => 'A')
\$BIG_INT_LIT	(1..V-3 => '0') & "298"
\$BIG_REAL_LIT	(1..V-5 => '0') & "690.0"
\$BIG_STRING1	'' & (1..V/2 => 'A') & ''
\$BIG_STRING2	'' & (1..V-1-V/2 => 'A') & '1' & ''
\$BLANKS	(1..V-20 => ' ')
\$MAX_LEN_INT_BASED_LITERAL	"2:" & (1..V-5 => '0') & "11:"
\$MAX_LEN_REAL_BASED_LITERAL	"16:" & (1..V-7 => '0') & "F.E:"
\$MAX_STRING_LITERAL	"CCCCCCCC10CCCCCCCC20CCCCCCCC30CCCCCCCC40C CCCCCCCC50CCCCCCCC60CCCCCCCC70CCCCCCCC80CCCCCCCC90CCCCCCCC100CCCC CCCC110CCCCCCCC120CCCCCCCC130CCCCCCCC140CCCCCCCC150CCCCCCCC160CCCCCCCC 170CCCCCCCC180CCCCCCCC190CCCCCCCC200CCCCCCCC210CCCCCCCC220CCCCCCCC230 CCCCC238"

MACRO PARAMETERS

The following table lists all of the other macro parameters and their respective values.

Macro Parameter	Macro Value
\$MAX_IN_LEN	240
\$ACC_SIZE	16
\$ALIGNMENT	1
\$COUNT_LAST	32766
\$DEFAULT_MEM_SIZE	65536
\$DEFAULT_STOR_UNIT	16
\$DEFAULT_SYS_NAME	MIL_STD_1750A
\$DELTA_DOC	2#1.0#E-31
\$ENTRY_ADDRESS	SYSTEM.ADDRESS'(16#0000_000D#)
\$ENTRY_ADDRESS1	SYSTEM.ADDRESS'(16#0000_000E#)
\$ENTRY_ADDRESS2	SYSTEM.ADDRESS'(16#0000_000F#)
\$FIELD_LAST	20
\$FILE_TERMINATOR	' '
\$FIXED_NAME	NO_SUCH_TYPE
\$FLOAT_NAME	NO_SUCH_TYPE
\$FORM_STRING	""
\$FORM_STRING2	"CANNOT_RESTRICT_FILE_CAPACITY"
\$GREATER_THAN_DURATION	100_000.0
\$GREATER_THAN_DURATION_BASE_LAST	131_073.0
\$GREATER_THAN_FLOAT_BASE_LAST	1.80141E+38
\$GREATER_THAN_FLOAT_SAFE_LARGE	1.7014111E+38

MACRO PARAMETERS

\$GREATER_THAN_SHORT_FLOAT_SAFE_LARGE
1.7014111E+38

\$HIGH_PRIORITY 200

\$ILLEGAL_EXTERNAL_FILE_NAME1
ILLEGAL_EXTERNAL_FILE_NAME1

\$ILLEGAL_EXTERNAL_FILE_NAME2
ILLEGAL_EXTERNAL_FILE_NAME2

\$INAPPROPRIATE_LINE_LENGTH
-1

\$INAPPROPRIATE_PAGE_LENGTH
-1

\$INCLUDE_PRAGMA1 "PRAGMA INCLUDE ("A28006D1.TST")"

\$INCLUDE_PRAGMA2 "PRAGMA INCLUDE ("B28006F1.TST")"

\$INTEGER_FIRST -32768

\$INTEGER_LAST 32767

\$INTEGER_LAST_PLUS_1 32768

\$INTERFACE_LANGUAGE CLink

\$LESS_THAN_DURATION -100_000.0

\$LESS_THAN_DURATION_BASE_FIRST
-131_073.0

\$LINE_TERMINATOR ' '

\$LOW_PRIORITY 10

\$MACHINE_CODE_STATEMENT
Two_Opnds' (LR, (R_am,R0), (R_am,R1));

\$MACHINE_CODE_TYPE Instruction_Mnemonic

\$MANTISSA_DOC 31

\$MAX_DIGITS 9

\$MAX_INT 2147483647

\$MAX_INT_PLUS_1 2147483648

\$MIN_INT -2147483648

MACRO PARAMETERS

\$NAME	NO_SUCH_TYPE_AVAILABLE
\$NAME_LIST	MIL_STD_1750A
\$NAME_SPECIFICATION1	DUA2:[ACVC11.1750A.TESTBED]X2120A.;1
\$NAME_SPECIFICATION2	DUA2:[ACVC11.1750A.TESTBED]X2120B.;1
\$NAME_SPECIFICATION3	DUA2:[ACVC11.1750A.TESTBED]X3119A.;1
\$NEG_BASED_INT	16#FFFFFFFE#
\$NEW_MEM_SIZE	1048576
\$NEW_STOR_UNIT	16
\$NEW_SYS_NAME	MIL_STD_1750A
\$PAGE_TERMINATOR	' '
\$RECORD_DEFINITION	record Operation: Instruction_Mnemonic; Operand_1: Operand; Operand_2: Operand; end record;
\$RECORD_NAME	Two_Opnds
\$TASK_SIZE	16
\$TASK_STORAGE_SIZE	1024
\$TICK	0.0001
\$VARIABLE_ADDRESS	SYSTEM.ADDRESS'(16#0000_0004#)
\$VARIABLE_ADDRESS1	SYSTEM.ADDRESS'(16#0000_0005#)
\$VARIABLE_ADDRESS2	SYSTEM.ADDRESS'(16#0000_0006#)
\$YOUR_PRAGMA	NO_SUCH_PRAGMA

APPENDIX B
COMPILATION SYSTEM OPTIONS

The compiler options of this Ada implementation, as described in this Appendix, are provided by the customer. Unless specifically noted otherwise, references in this appendix are to compiler documentation and not to this report.

Compilation switches for Tardan Ada VMS 1750A.

/1750A	Invoke the cross compiler targeted to MIL-STD-1750A computer. This qualifier is mandatory to invoke the 1750A-targeted compiler.
/CROSS_REFERENCE /NOCROSS_REFERENCE [default]	Controls whether the compiler generates cross-reference information in the object code file to be used by the TXREF tool (see Section 4.6). This qualifier may be used only with the Tardan Tool Set.
/DEBUG /NODEBUG [default]	Controls whether debugging information is included in the object code file. It is not necessary for all object modules to include debugging information to obtain a linkable image, but use of this qualifier is encouraged for all compilations. No significant execution-time penalty is incurred with this qualifier.
/ERROR_LIMIT=n	Stop compilation and produce a listing after n errors are encountered, where n is in the range 0..255. The default value for n is 255. The /ERROR_LIMIT qualifier cannot be negated.
/FIXUP[=option]	When package MACHINE_CODE is used, controls whether the compiler attempts to alter operand address modes when those address modes are used incorrectly. The available options are: QUIET The compiler attempts to generate extra instruction to fix incorrect address modes in the array aggregates operand field. WARN The compiler attempts to generate extra instructions to fix incorrect address modes. A warning message is issued if such a "fixup" is required. NONE The compiler does not attempt to fix any machine code insertion that has incorrect address modes. An error message is issued for any machine code insertion that is incorrect. When no form of this qualifier is supplied in the command line, the default condition is /FIXUP=QUIET. For more information on machine code insertions,

refer to Section 5.10 of this manual.

/LIBRARY=library-name Specifies the library into which the file is to be compiled. The compiler reads any ADALIB.INI files in the default directory.

/LIST[=option]
/NOLIST

Controls whether a listing file is produced. If produced, the file has the source file name and a .LIS extension. The available options are:

ALWAYS	Always produce a listing file
NEVER	Never produce a listing file, equivalent to /NOLIST
ERROR	Produce a listing file only if a compilation error or warning occurs

When no form of this qualifier is supplied in the command line, the default condition is /LIST=ERROR. When the LIST qualifier is supplied without an option, the default option is ALWAYS.

/MACHINE_CODE[=option]

Controls whether the compiler produces an assembly code file in addition to an object file, which is always generated. The assembly code file is not intended to be input to an assembler, but serves as documentation only. The available options are:

NONE	Do not produce an assembly code file.
INTERLEAVE	Produce an assembly code file which interleaves source code with the machine code (see Section 4.5.4). Ada source appears as assembly language comments.
NOINTERLEAVE	Produce an assembly code file without interleaving.

When no form of this qualifier is supplied in the command line, the default option is NONE. Specifying the MACHINE_CODE qualifier without an option is equivalent to supplying /MACHINE_CODE=NOINTERLEAVE.

/NODOUBLE_STORE

Causes the compiler to emit two single store instructions instead of a single double store instruction.

/NOENUMIMAGE

Causes the compiler to omit data segments with the text of enumeration literals. This text is normally produced for exported enumeration types in order to support the text attributes ('IMAGE, 'VALUE and

'WIDTH). You should use /NOENUMIMAGE only when you can guarantee that no unit that will import the enumeration type will use any of its text attributes. However, if you are compiling a unit with an enumeration type that is not visible to other compilation units, this qualifier is not needed. The compiler can recognize when the text attributes are not used and will not generate the supporting strings. This qualifier is intended to reduce the size of execution images for embedded systems. The /NOENUMIMAGE qualifier cannot be negated.

/OPT=n

Controls the level of optimization performed by the compiler, requested by n. The /OPT qualifier cannot be negated. The optimization levels available are:

n = 0 Minimum - Performs context determination, constant folding, algebraic manipulation, and short circuit analysis. Inlines are not expanded.

n = 1 Low - Performs level 0 optimizations plus common subexpression elimination and equivalence propagation within basic blocks. It also optimizes evaluation order. Inlines are not expanded.

n = 2 Best tradeoff for space/time - the default level. Performs level 1 optimizations plus flow analysis which is used for common subexpression elimination and equivalence propagation across basic blocks. It also performs invariant expression hoisting, dead code elimination, and assignment killing. Level 2 also performs lifetime analysis to improve register allocation. It also performs inline expansion of subprogram calls indicated by Pragma INLINE, if possible.

n = 3 Time - Performs level 2 optimizations plus inline expansion of subprogram calls which the optimizer decides are profitable to expand (from an execution time perspective). Other optimizations which improve execution time at a cost to image size are performed only at this level.

/PHASES	
/NOPHASES [default]	Controls whether the compiler announces each phase of processing as it occurs. These phases indicate progress of the compilation. If there is an error in compilation, the error message will direct users to a specific location as opposed to the more general /PHASES.
/REFINE	
/NOREFINE [default]	Controls whether the compiler, when compiling a library unit, determines whether the unit is a refinement of its previous version and, if so, does not make dependent units obsolete. The default is /NOREFINE.
/REPLACE	Forces the compiler to accept an attempt to compile a unit imported from another library which is normally prohibited.
/SAVE_SOURCE [default]	
/NOSAVE_SOURCE	Suppresses the creation of a registered copy of the source code in the library directory for use by the REMAKE and MAKE subcommands to AL17.
/SUPPRESS[=(option, ...)]	Suppresses the specific checks identified by the options supplied. The parentheses may be omitted if only one option is supplied. The /SUPPRESS qualifier has the same effect as a global pragma SUPPRESS applied to the source file. If the source program also contains a pragma SUPPRESS, then a given check is suppressed if either the pragma or the qualifier specifies it; that is, the effect of a pragma SUPPRESS cannot be negated with the command line qualifier. The /SUPPRESS qualifier cannot be negated.
The available options are:	
ALL	Suppress all checks. This is the default if the qualifier is supplied with no option.
ACCESS_CHECK	As specified in Ada LRM, Section 11...
CONSTRAINT_CHECK	Equivalent of (ACCESS_CHECK, INDEX_CHECK, DISCRIMINANT_CHECK, LENGTH_CHECK, RANGE_CHECK).

<u>DISCRIMINANT_CHECK</u>	As specified in the Ada LRM, Section 11.7.
<u>DIVISION_CHECK</u>	Will suppress compile-time checks for division by zero, but the hardware does not permit efficient runtime checks, so none are done..
<u>ELABORATION_CHECK</u>	As specified in the Ada LRM, Section 11.7.
<u>INDEX_CHECK</u>	As specified in the Ada LRM, Section 11.7.
<u>LENGTH_CHECK</u>	As specified in the Ada LRM, Section 11.7.
<u>NONE</u>	No checks are suppressed. This is the default if the qualifier is not supplied on the command line.
<u>OVERFLOW_CHECK</u>	Will suppress compile-time checks for overflow, but the hardware does not permit efficient runtime checks, so none are done.
<u>RANGE_CHECK</u>	As specified in the Ada LRM, Section 11.7.
<u>STORAGE_CHECK</u>	As specified in the Ada LRM, Section 11.7. Suppresses only stack checks in generated code, not the checks made by the allocator as a result of a new operation.
<u>/SYNTAX_ONLY</u>	Parses a unit and reports syntax errors, then stops compilation without entering a unit in the library.
<u>/WARNINGS [default]</u> <u>/NOWARNINGS</u>	Controls whether the warning messages generated by the compiler are displayed to the user at the

terminal and in a listing file, if produced. While suppressing warning messages also halts display of informational messages, it does not suppress Error, Fatal_Error.

LINKER OPTIONS

The linker options of this Ada implementation, as described in this Appendix, are provided by the customer. Unless specifically noted otherwise, references in this appendix are to linker documentation and not to this report.

Linker switches for VMS hosted Tartan Ada compilers.

COMMAND QUALIFIERS

This section describes the command qualifiers available to a user who directly invokes the linker. The qualifier names can be abbreviated to unique prefixes; the first letter is sufficient for all current qualifier names. The qualifier names are not case sensitive.

/CONTROL=file	The specified file contains linker control commands. Only one such file may be specified, but it can include other files using the CONTROL command. Every invocation of the linker must specify a control file.
/OUTPUT=file	The specified file is the name of the first output object file. The module name for this file will be null. Only one output file may be specified in this manner. Additional output files may be specified in the linker control file.
/ALLOCATIONS	Produce a link map showing the section allocations.
/UNUSEDSECTIONS	Produce a link map showing the unused sections.
/SYMBOLS	Produce a link map showing global and external symbols.
/RESOLVEMODULES	This causes the linker to not perform unused section elimination. Specifying this option will generally make your program larger, since unreferenced data within object files will not be eliminated. Refer to Sections RESOLVE_CMD and USE_PROCESSING for information on the way that unused section elimination works.
/MAP	Produce a link map containing all information except the unused section listings.

Note that several listing options are permitted. This is because link maps for real systems can become rather large, and writing them consumes a significant fraction of the total link time. Options specifying the contents of the link map can be combined, in which case the resulting map will contain all the information specified by any of the switches. The name of the file containing the link map is specified by the LIST command in the linker control file. If your control file does not specify a name and you request a listing, the listing will be written to the default output stream.

APPENDIX C

APPENDIX F OF THE Ada STANDARD

The only allowed implementation dependencies correspond to implementation-dependent pragmas, to certain machine-dependent conventions as mentioned in Chapter 13 of the Ada Standard, and to certain allowed restrictions on representation clauses. The implementation-dependent characteristics of this Ada implementation, as described in this Appendix, are provided by the customer. Unless specifically noted otherwise, references in this Appendix are to compiler documentation and not to this report. The package STANDARD is presented in this implementation's Appendix F on page 5-11.

Chapter 5

Appendix F to MIL-STD-1815A

This chapter contains the required Appendix F to the LRM which is *Military Standard, Ada Programming Language*, ANSI/MIL-STD-1815A (American National Standards Institute, Inc., February 17, 1983).

5.1. PRAGMAS

5.1.1. Predefined Pragmas

This section summarizes the effects of and restrictions on predefined pragmas.

- Access collections are not subject to automatic storage reclamation so pragma CONTROLLED has no effect. Space deallocated by means of UNCHECKED_DEALLOCATION will be reused by the allocation of new objects.
- Pragma ELABORATE is supported.
- Pragma INLINE is supported.
- Pragma INTERFACE is supported. It is assumed that the foreign code interfaced adheres to Tartan Ada calling conventions as well as Tartan Ada parameter passing mechanisms. Any other Language_Name will be accepted, but ignored, and the default will be used.
- Pragma LIST is supported but has the intended effect only if the command qualifier LIST=ALWAYS was supplied for compilation, and the listing generated was not due to the presence of errors and/or warnings.
- Pragma MEMORY_SIZE is accepted but no value other than that specified in Package SYSTEM (Section 5.3) is allowed.
- Pragma OPTIMIZE is supported except when at the outer level (that is, in a package specification or body).
- Pragma PACK is supported.
- Pragma PAGE is supported but has the intended effect only if the command qualifier LIST=ALWAYS was supplied for compilation, and the listing generated was not due to the presence of errors and/or warnings.
- Pragma PRIORITY is supported.
- Pragma STORAGE_UNIT is accepted but no value other than that specified in Package SYSTEM (Section 5.3) is allowed.
- Pragma SHARED is not supported. No warning is issued if it is supplied.
- Pragma SUPPRESS is supported.
- Pragma SYSTEM_NAME is accepted but no value other than that specified in Package SYSTEM (Section 5.3) is allowed.

5.1.2.1. *Pragma LINKAGE_NAME*

The pragma **LINKAGE_NAME** associates an Ada entity with a string that is meaningful externally; e.g., to a linkage editor. It takes the form

```
pragma LINKAGE_NAME (Ada-simple-name, string-constant)
```

The *Ada-simple-name* must be the name of an Ada entity declared in a package specification. This entity must be one that has a runtime representation; e.g., a subprogram, exception or object. It may not be a named number or string constant. The pragma must appear after the declaration of the entity in the same package specification.

The effect of the pragma is to cause the *string-constant* to be used in the generated assembly code as an external name for the associated Ada entity. It is the responsibility of the user to guarantee that this string constant is meaningful to the linkage editor and that no illegal linkname clashes arise.

This pragma has no effect when applied to a library subprogram or to a *renames* declaration; in the latter case, no warning message is given.

When determining the maximum allowable length for the external linkage name, keep in mind that the compiler will generate names for elaboration flags simply by appending the suffix #GOTO. Therefore, the external linkage name has 5 fewer significant characters than the lower limit of other tools that need to process the name (e.g., 40 in the case of the Tartan Linker).

5.1.2.2. *Pragma FOREIGN_BODY*

In addition to Pragma INTERFACE, Tartan Ada supplies Pragma FOREIGN_BODY as a way to access subprograms in other languages.

Unlike Pragma INTERFACE, Pragma FOREIGN_BODY allows access to objects and exceptions (in addition to subprograms) to and from other languages.

Some restrictions on Pragma FOREIGN_BODY that are not applicable to Pragma INTERFACE are:

- Pragma FOREIGN_BODY must appear in a non-generic library package.
- All objects, exceptions and subprograms in such a package must be supplied by a foreign object module.
- Types may not be declared in such a package.

Use of the pragma FOREIGN_BODY dictates that all subprograms, exceptions and objects in the package are provided by means of a foreign object module. In order to successfully link a program including a foreign body, the object module for that body must be provided to the library using the AL17 FOREIGN command described in sections 3.3.3 and 9.5.5. The pragma is of the form:

```
pragma FOREIGN_BODY (Language_name [, elaboration_routine_name])
```

The parameter *Language_name* is a string intended to allow the compiler to identify the calling convention used by the foreign module (but this functionality is not yet in operation). Currently, the programmer must ensure that the calling convention and data representation of the foreign body procedures are compatible with those used by the Tartan Ada compiler. Subprograms called by tasks should be reentrant.

The optional *elaboration_routine_name* string argument is a linkage name identifying a routine to initialize the package. The routine specified as the *elaboration_routine_name*, which will be called for the elaboration of this package body, must be a global routine in the object module provided by the user.

A specification that uses this pragma may contain only subprogram declarations, object declarations that use an unconstrained type mark, and number declarations. Pragmas may also appear in the package. The type mark for an object cannot be a task type, and the object declaration must not have an initial value expression. The pragma must be given prior to any declarations within the package specification. If the pragma is not located before the first declaration, or any restriction on the declarations is violated, the pragma is ignored and a warning is generated.

The foreign body is entirely responsible for initializing objects declared in a package utilizing pragma FOREIGN_BODY. In particular, the user should be aware that the implicit initializations described in LRM 3.2.1 are not done by the compiler. (These implicit initializations are associated with objects of access types, certain record types and composite types containing components of the preceding kinds of types.)

Pragma `LINKAGE_NAME` should be used for all declarations in the package, including any declarations in a nested package specification to be sure that there are no conflicting link names. If pragma `LINKAGE_NAME` is not used, the cross-reference qualifier, `/CROSS_REFERENCE`, (see Section 4.2) should be used when invoking the compiler and the resulting cross-reference table of linknames inspected to identify the linknames assigned by the compiler and determine that there are no conflicting linknames (see also Section 4.6). In the following example, we want to call a function `plmn` which computes polynomials and is written in assembler.

```

package MATH_FUNCTIONS is
  pragma FOREIGN_BODY ("assembler");
  function POLYNOMIAL (X:INTEGER) return INTEGER;
    --Ada spec matching the assembler routine
  pragma LINKAGE_NAME (POLYNOMIAL, "plmn");
    --Force compiler to use name "plmn" when referring to this
    -- function
end MATH_FUNCTIONS;

with MATH_FUNCTIONS; use MATH_FUNCTIONS;
procedure MAIN is
  X:INTEGER := POLYNOMIAL(10);
  -- Will generate a call to "plmn"
begin ...
end MAIN;

```

To compile, link and run the above program, you do the following steps:

1. Compile `MATH_FUNCTIONS`
2. Compile `MAIN`
3. Obtain an object module (e.g. `math.TOF`) containing the compiled code for `plmn`, converted to Tartan Object File Format (TOFF) using the `its_to_toff` utility (See *Object File Utilities*, Chapter 4)
4. Issue the command

AL17 FOREIGN_BODY `math_functions` MATH.TOF

5. Issue the command

AL17 LINK MAIN

Without Step 4, an attempt to link will produce an error message informing you of a missing package body for `MATH_FUNCTIONS`.

Using an Ada body from another Ada program library. The user may compile a body written in Ada for a specification into the library, regardless of the language specified in the pragma contained in the specification. This capability is useful for rapid prototyping, where an Ada package may serve to provide a simulated response for the functionality that a foreign body may eventually produce. It also allows the user to replace a foreign body with an Ada body without recompiling the specification.

The user can either compile an Ada body into the library, or use the command `AL17 FOREIGN` (see Sections 3.3.3 and 9.5.5) to use an Ada body from another library. The Ada body from another library must have been compiled under an identical specification. The pragma `LINKAGE_NAME` must have been applied to all entities declared in the specification. The only way to specify the linkname for the elaboration routine of an Ada body is with the pragma `FOREIGN_BODY`.

5.2. IMPLEMENTATION-DEPENDENT ATTRIBUTES

No implementation-dependent attributes are currently supported.

5.3. SPECIFICATION OF THE PACKAGE SYSTEM

The parameter values specified for MIL-STD-1750A in package SYSTEM [LRM 13.7.1 and Annex C] are:

```
package SYSTEM is
  type ADDRESS is new INTEGER;
  type NAME is (MIL_STD_1750A);
  SYSTEM_NAME : constant NAME := MIL_STD_1750A;
  STORAGE_UNIT : constant := 16;
  MEMORY_SIZE : constant := 65536;
  MAX_INT : constant := 2_147_483_647;
  MIN_INT : constant := -MAX_INT - 1;
  MAX_DIGITS : constant := 9;
  MAX_MANTISSA : constant := 31;
  FINE_DELTA : constant := 2#1.0#e-31;
  TICK : constant := 0.0001;
  subtype PRIORITY is INTEGER range 10 .. 200;
  DEFAULT_PRIORITY : constant PRIORITY := PRIORITY'FIRST;
  RUNTIME_ERROR : exception;
end SYSTEM;
```

5.4. RESTRICTIONS ON REPRESENTATION CLAUSES

The following sections explain the basic restrictions for representation specifications followed by additional restrictions applying to specific kinds of clauses.

5.4.1. Basic Restriction

The basic restriction on representation specifications [LRM 13.1] is that they may be given only for types declared in terms of a type definition, excluding a generic_type_definition (LRM 12.1) and a private_type_definition (LRM 7.4). Any representation clause in violation of these rules is not obeyed by the compiler; an error message is issued.

Further restrictions are explained in the following sections. Any representation clauses violating those restrictions cause compilation to stop and a diagnostic message to be issued.

5.4.2. Length Clauses

Length clauses [LRM 13.2] are, in general, supported. For details, refer to the following sections.

5.4.2.1. Size Specifications for Types

The rules and restrictions for size specifications applied to types of various classes are described below.

The following principle rules apply:

1. The size is specified in bits and must be given by a static expression.
2. The specified size is taken as a mandate to store objects of the type in the given size wherever feasible. No attempt is made to store values of the type in a smaller size, even if possible. The following rules apply with regard to feasibility:
 - An object that is not a component of a composite object is allocated with a size and alignment that is referable on the target machine; that is, no attempt is made to create objects of non-referable size on the stack. If such stack compression is desired, it can be achieved by the user by combining multiple stack variables in a composite object; for example

```

type My_Enum is (A,B);
for My_enum'size use 1;
V,W: My_enum; -- will occupy two storage
              -- units on the stack
              -- (if allocated at all)
type rec is record
  V,W: My_enum;
end record;
pragma Pack(rec);
O: rec;          -- will occupy one storage unit

```

- A formal parameter of the type is sized according to calling conventions rather than size specifications of the type. Appropriate size conversions upon parameter passing take place automatically and are transparent to the user.

- Adjacent bits to an object that is a component of a composite object, but whose size is non-referable, may be affected by assignments to the object, unless these bits are occupied by other components of the composite object; that is, whenever possible, a component of non-referable size is made referable.

In all cases, the compiler generates correct code for all operations on objects of the type, even if they are stored with differing representational sizes in different contexts.

Note: A size specification cannot be used to force a certain size in value operations of the type; for example

```

type my_int is range 0..65535;
for my_int'size use 16; -- o.k.
A,B: my_int;
...A + B... -- this operation will generally be
              -- executed on 32-bit values

```

3. A size specification for a type specifies the size for objects of this type and of all its subtypes. For components of composite types, whose subtype would allow a shorter representation of the component, no attempt is made to take advantage of such shorter representations. In contrast, for types without a length clause, such components may be represented in a lesser number of bits than the number of bits required to represent all values of the type. Thus, in the example

```

type MY_INT is range 0..2**15-1;
for MY_INT'SIZE use 16; -- (1)
subtype SMALL_MY_INT is MY_INT range 0..255;
type R is record
  ...
  X: SMALL_MY_INT;
  ...
end record;

```

the component R.X will occupy 16 bits. In the absence of the length clause at (1), R.X may be represented in 8 bits.

Size specifications for access types must coincide with the default size chosen by the compiler for the type.

Size specifications are not supported for floating-point types or task types.

No useful effect can be achieved by using size specifications for these types.

5.4.2.2. Size Specification for Scalar Types

The specified size must accommodate all possible values of the type including the value 0 (even if 0 is not in the range of the values of the type). For numeric types with negative values the number of bits must account for the sign bit. No skewing of the representation is attempted. Thus

```

type my_int is range 100..101;

```

requires at least 7 bits, although it has only two values, while

```
type my_int is range -101..-100;  
requires 8 bits to account for the sign bit.
```

A size specification for a real type does not affect the accuracy of operations on the type. Such influence should be exerted via the accuracy_definition of the type (LRM 3.5.7, 3.5.9).

A size specification for a scalar type may not specify a size larger than the largest operation size supported by the target architecture for the respective class of values of the type.

5.4.2.3. Size Specification for Array Types

A size specification for an array type must be large enough to accommodate all components of the array under the densest packing strategy. Any alignment constraints on the component type (see Section 5.4.7) must be met.

Arrays with component size less than or equal to 16 bits are densely packed. No pad or unused bits exist between components. Arrays with component size greater than 16 bits are padded up to the next 16-bit boundary. The size of the component type cannot be influenced by a length clause for an array. Within the limits of representing all possible values of the component subtype (but not necessarily of its type), the representation of components may, however, be reduced to the minimum number of bits, unless the component type carries a size specification.

If there is a size specification for the component type, but not for the array type, the component size is rounded up to a referable size, unless pragma PACK is given. This applies even to boolean types or other types that require only a single bit for the representation of all values.

5.4.2.4. Size Specification for Record Types

A size specification for a record type does not influence the default type mapping of a record type. The size must be at least as large as the number of bits determined by type mapping. Influence over packing of components can be exerted by means of (partial) record representation clauses or by Pragma PACK.

Neither the size of component types, nor the representation of component subtypes can be influenced by a length clause for a record.

The only implementation-dependent components allocated by Tartan Ada in records contain dope information for arrays whose bounds depend on discriminants of the record or contain relative offsets of components within a record layout for record components of dynamic size. These implementation-dependent components cannot be named or sized by the user.

A size specification cannot be applied to a record type with components of dynamically determined size.

Note: Size specifications for records can be used only to widen the representation accomplished by padding at the beginning or end of the record. Any narrowing of the representation over default type mapping must be accomplished by representation clauses or pragma PACK.

5.4.2.5. Specification of Collection Sizes

The specification of a collection size causes the collection to be allocated with the specified size. It is expressed in storage units and need not be static; refer to package SYSTEM for the meaning of storage units.

Any attempt to allocate more objects than the collection can hold causes a STORAGE_ERROR exception to be raised. Dynamically sized records or arrays may carry hidden administrative storage requirements that must be accounted for as part of the collection size. Moreover, alignment constraints on the type of the allocated objects may make it impossible to use all memory locations of the allocated collection. No matter what the requested object size, the allocator must allocate a minimum of 2 words per object. This lower limit is necessary for administrative overhead in the allocator. For example, a request of 5 words results in an allocation of 5 words; a request of 1 word results in an allocation of 2 words.

In the absence of a specification of a collection size, the collection is extended automatically if more objects are allocated than possible in the collection originally allocated with the compiler-established default size. In this case, STORAGE_ERROR is raised only when the available target memory is exhausted. If a collection size of zero is specified, no access collection is allocated.

5.4.2.6. Specification of Task Activation Size

The specification of a task activation size causes the task activation to be allocated with the specified size. It is expressed in storage units; refer to package SYSTEM for the meaning of storage units.

Any attempt to exceed the activation size during execution causes a STORAGE_ERROR exception to be raised. Unlike collections, there is no extension of task activations.

5.4.2.7. Specification of 'SMALL'

Only powers of 2 are allowed for 'SMALL'.

The length of the representation may be affected by this specification. If a size specification is also given for the type, the size specification takes precedence; the specification of 'SMALL' must then be accommodatable within the specified size.

5.4.3. Enumeration Representation Clauses

For enumeration representation clauses [LRM 13.3], the following restrictions apply:

- The internal codes specified for the literals of the enumeration type may be any integer value between INTEGER'FIRST and INTEGER'LAST. It is strongly advised to not provide a representation clause that merely duplicates the default mapping of enumeration types, which assigns consecutive numbers in ascending order starting with 0, since unnecessary runtime cost is incurred by such duplication. It should be noted that the use of attributes on enumeration types with user-specified encodings is costly at run time.
- Array types, whose index type is an enumeration type with non-contiguous value encodings, consist of a contiguous sequence of components. Indexing into the array involves a runtime translation of the index value into the corresponding position value of the enumeration type.

5.4.4. Record Representation Clauses

The alignment clause of record representation clauses [LRM 13.4] is observed.

Static objects may be aligned at powers of 2 up to a page boundary. The specified alignment becomes the minimum alignment of the record type, unless the minimum alignment of the record forced by the component allocation and the minimum alignment requirements of the components is already more stringent than the specified alignment.

The component clauses of record representation clauses are allowed only for components and discriminants of statically determinable size. Not all components need to be present. Component clauses for components of variant parts are allowed only if the size of the record type is statically determinable for every variant.

The size specified for each component must be sufficient to allocate all possible values of the component subtype (but not necessarily the component type). The location specified must be compatible with any alignment constraints of the component type; an alignment constraint on a component type may cause an implicit alignment constraint on the record type itself.

If some, but not all, discriminants and components of a record type are described by a component clause, then the discriminants and components without component clauses are allocated after those with component clauses; no attempt is made to utilize gaps left by the user-provided allocation.

5.4.5. Address clauses

Address clauses [LRM 13.5] are supported with the following restrictions:

- When applied to an object, an address clause becomes a linker directive to allocate the object at the given address. For any object not declared immediately within a top-level library package, the address clause is meaningless. Address clauses applied to local packages are not supported by Tartan Ada. Address clauses applied to library packages are prohibited by the syntax; therefore, an address clause can be applied to a package only if it is a body stub.

- Address clauses applied to subprograms and tasks are implemented according to the LRM rules. When applied to an entry, the specified value identifies an interrupt in a manner customary for the target. Immediately after a task is created, a runtime call is made for each of its entries having an address clause, establishing the proper binding between the entry and the interrupt.
- A specified address must be an Ada static expression.

5.4.6. *Pragma PACK*

Pragma PACK [LRM 13.1] is supported. For details, refer to the following sections.

5.4.6.1. *Pragma PACK for Arrays*

If pragma PACK is applied to an array, the densest possible representation is chosen. For details of packing, refer to the explanation of size specifications for arrays (Section 5.4.2.3).

If, in addition, a length clause is applied to

1. The array type, the pragma has no effect, since such a length clause already uniquely determines the array packing method.
2. The component type, the array is packed densely, observing the component's length clause. Note that the component length clause may have the effect of preventing the compiler from packing as densely as would be the default if pragma PACK is applied where there was no length clause given for the component type.

5.4.6.2. *The Predefined Type String*

Package STANDARD applies Pragma PACK to the type string.

However, when applied to character arrays, this pragma cannot be used to achieve denser packing than is the default for the target: 1 character per 16-bit word.

5.4.6.3. *Pragma PACK for Records*

If pragma PACK is applied to a record, the densest possible representation is chosen that is compatible with the sizes and alignment constraints of the individual component types. Pragma PACK has an effect only if the sizes of some component types are specified explicitly by size specifications and are of non-referable nature. In the absence of pragma PACK, such components generally consume a referable amount of space.

It should be noted that the default type mapping for records maps components of boolean or other types that require only a single bit to a single bit in the record layout, if there are multiple such components in a record. Otherwise, it allocates a referable amount of storage to the component.

If pragma PACK is applied to a record for which a record representation clause has been given detailing the allocation of some but not all components, the pragma PACK affects only the components whose allocation has not been detailed. Moreover, the strategy of not utilizing gaps between explicitly allocated components still applies.

5.4.7. *Minimal Alignment for Types*

Certain alignment properties of values of certain types are enforced by the type mapping rules. Any representation specification that cannot be satisfied within these constraints is not obeyed by the compiler and is appropriately diagnosed.

Alignment constraints are caused by properties of the target architecture, most notably by the capability to extract non-aligned component values from composite values in a reasonably efficient manner. Typically, restrictions exist that make extraction of values that cross certain address boundaries very expensive, especially in contexts involving array indexing. Permitting data layouts that require such complicated extractions may impact code quality on a broader scale than merely in the local context of such extractions.

Instead of describing the precise algorithm of establishing the minimal alignment of types, we provide the general rule that is being enforced by the alignment rules:

- No object of scalar type including components or subcomponents of a composite type, may span a target-dependent address boundary that would mandate an extraction of the object's value to be performed by two or more extractions.

5.5. IMPLEMENTATION-GENERATED COMPONENTS IN RECORDS

The only implementation-dependent components allocated by Tartan Ada in records contain dope information for arrays whose bounds depend on discriminants of the record. These components cannot be named by the user.

5.6. INTERPRETATION OF EXPRESSIONS APPEARING IN ADDRESS CLAUSES

Section 13.5.1 of the Ada Language Reference Manual describes a syntax for associating interrupts with task entries. Tartan Ada implements the address clause

for TOENTRY use at intID;

by associating the interrupt specified by intID with the toentry entry of the task containing this address clause. The interpretation of intID is both machine and compiler dependent.

The Ada/1750A runtimes provide 16 interrupts that may be associated with task entries. These interrupts are identified by an integer in the range 0..15. The intID argument of an address clause is interpreted as follows:

- If the argument is in the range 0..15, a full support interrupt association is made between the interrupt specified by the argument and the task entry.
- If the argument is in the range 16..31, a fast interrupt association is made between the interrupt number (argument-16) and the task entry.
- If the argument is outside the range 0..31, the program is erroneous.

For the difference between full support and fast interrupt handling, refer to Section 8.5.6.

5.7. RESTRICTIONS ON UNCHECKED CONVERSIONS

Tartan supports `UNCHECKED_CONVERSION` with a restriction that requires the sizes of both source and target types to be known at compile time. The sizes need not be the same. If the value in the source is wider than that in the target, the source value will be truncated. If narrower, it will be zero-extended. Calls on instantiations of `UNCHECKED_CONVERSION` are made inline automatically.

5.8. IMPLEMENTATION-DEPENDENT ASPECTS OF INPUT-OUTPUT PACKAGES

Tartan Ada supplies the predefined input/output packages `DIRECT_IO`, `SEQUENTIAL_IO`, `TEXT_IO`, and `LOW_LEVEL_IO` as required by LRM Chapter 14. However, since MIL-STD-1750A is used in embedded applications lacking both standard I/O devices and file systems, the functionality of `DIRECT_IO`, `SEQUENTIAL_IO`, and `TEXT_IO` is limited.

`DIRECT_IO` and `SEQUENTIAL_IO` raise `USE_ERROR` if a file open or file access is attempted. `TEXT_IO` is supported to `CURRENT_OUTPUT` and from `CURRENT_INPUT`. A routine that takes explicit file names raises `USE_ERROR`. `LOW_LEVEL_IO` for MIL-STD-1750A provides an interface by which the user may execute XIO operations. In both the `SEND_CONTROL` and `RECEIVE_CONTROL` procedures, the device parameter specifies an XIO address while the data parameter is the single word of data transferred.

The specification for package `LOW_LEVEL_IO` is as follows:

```
package LOW_LEVEL_IO is

-- The parameters to SEND_CONTROL and RECEIVE_CONTROL are:
-- device : XIO command field as defined in section 5.1
--          of MIL-STD-1750a.
-- data : An integer value read or written depending
--        upon the XIO command used. Some do neither.
-- SEND_CONTROL and RECEIVE control do exactly the same thing.
-- The existence of both of them, each with an "in out" parameter
-- for data, is at the insistence of the LRM.
procedure SEND_CONTROL(device : integer; data : in out integer);
procedure RECEIVE_CONTROL(device : integer; data : in out integer);

end LOW_LEVEL_IO;
```

5.9. OTHER IMPLEMENTATION CHARACTERISTICS

The following information is supplied in addition to that required by Appendix F to MIL-STD-1815A.

5.9.1. Definition of a Main Program

Any Ada library subprogram unit may be designated the main program for purposes of linking (using the AL17 LINK command) provided that the subprogram has no parameters.

Tasks initiated in imported library units follow the same rules for termination as other tasks [described in LRM 9.4 (6-10)]. Specifically, these tasks are not terminated simply because the main program has terminated. Terminate alternatives in selective wait statements in library tasks are therefore strongly recommended.

5.9.2. Implementation of Generic Units

All instantiations of generic units, except the predefined generic UNCHECKED_CONVERSION and UNCHECKED_DEALLOCATION subprograms, are implemented by code duplications. No attempt at sharing code by multiple instantiations is made in this release of Tartan Ada.

Tartan Ada enforces the restriction that the body of a generic unit must be compiled before the unit can be instantiated. It does not impose the restriction that the specification and body of a generic unit must be provided as part of the same compilation. A recompilation of the body of a generic unit will cause any units that instantiated this generic unit to become obsolete.

5.9.3. Implementation-Defined Characteristics in Package STANDARD

The implementation-dependent characteristics for MIL-STD-1750A in package STANDARD [Annex C] are:

```
package STANDARD is
  ...
  type INTEGER is range -32768 .. 32767;
  type FLOAT is digits 6 range -16#0.8000_00#E+32 .. 16#0.7FFF_FF#E+32;
  type LONG_INTEGER is range -2147483648 .. 2147483647;
  type LONG_FLOAT is digits 9 range -16#0.8000_0000_00#E+32 ..
  16#0.7FFF_FFFF_FF#E+32 ;
  type DURATION is delta 0.0001 range -86400.0 .. 86400.0;
  -- DURATION'SMALL = 2#1.0#E-14
  ...
end STANDARD;
```

5.9.4. Attributes of Type Duration

The type DURATION is defined with the following characteristics:

Attribute	Value
DURATION' DELTA	0.0001 sec
DURATION' SMALL	6.103516E ⁻⁵ sec
DURATION' FIRST	-86400.0 sec
DURATION' LAST	86400.0 sec

5.9.5. Values of Integer Attributes

Tartan Ada supports the predefined integer types INTEGER and LONG_INTEGER.

The range bounds of the predefined type INTEGER are:

INTEGER' FIRST = -2**15
 INTEGER' LAST = 2**15-1

The range bounds of the predefined type LONG_INTEGER are:

LONG_INTEGER' FIRST = -2**31
 LONG_INTEGER' LAST = 2**31-1

The range bounds for subtypes declared in package TEXT_IO are:

COUNT' FIRST = 0
 COUNT' LAST = INTEGER' LAST - 1

POSITIVE_COUNT' FIRST = 1
 POSITIVE_COUNT' LAST = INTEGER' LAST - 1

FIELD' FIRST = 0
 FIELD' LAST = 20

The range bounds for subtypes declared in packages DIRECT_IO are:

```
COUNT'FIRST = 0
COUNT'LAST = INTEGER'LAST/ELEMENT_TYPE'SIZE

POSITIVE_COUNT'FIRST = 1
POSITIVE_COUNT'LAST = COUNT'LAST
```

5.9.6. *Values of Floating-Point Attributes*

<u>Attribute</u>	<u>Value for FLOAT</u>
DIGITS	6
MANTISSA	21
EMAX	84
EPSILON approximately	16#0.1000_000#E-4 9.53674E-07
SMALL approximately	16#0.8000_000#E-21 2.58494E-26
LARGE approximately	16#0.FFFF_F80#E+21 1.93428E+25
SAFE_EMAX	127
SAFE_SMALL approximately	16#0.1000_000#E-31 2.93874E-39
SAFE_LARGE approximately	16#0.7FFF_FC0#E+32 1.70141E+38
FIRST approximately	-16#0.8000_000#E+32 -1.70141E+38
LAST approximately	16#0.7FFF_FFO#E+32 1.70141E+38
MACHINE_RADIX	2
MACHINE_MANTISSA	23
MACHINE_EMAX	127
MACHINE_EMIN	-128
MACHINE_ROUNDS	TRUE
MACHINE_OVERFLOWS	TRUE

<u>Attribute</u>	<u>Value for LONG FLOAT</u>
DIGITS	9
MANTISSA	31
EMAX	124
EPSILON approximately	16#0.4000_0000_00#E-7 9.3132257461548E-10
SMALL approximately	16#0.8000_0000_00#E-31 2.3509887016445E-38
LARGE approximately	16#0.FFFF_FFFE_00#E+31 2.1267647922655E+37
SAFE_EMAX	127
SAFE_SMALL approximately	16#0.1000_0000_00#E-31 2.9387358770557E-39
SAFE_LARGE approximately	16#0.7FFF_FFFF_00#E+32 1.7014118338124E+38
FIRST approximately	-16#0.8000_0000_00#E+32 -1.7014118346016E+38
LAST approximately	16#0.7FFF_FFFF_FF#E+32 1.7014118346047E+38
MACHINE_RADIX	2
MACHINE_MANTISSA	39
MACHINE_EMAX	127
MACHINE_EMIN	-128
MACHINE_ROUNDS	TRUE
MACHINE_OVERFLOWS	TRUE

5.10. SUPPORT FOR PACKAGE MACHINE_CODE

Package MACHINE_CODE provides an interface through which a user may request the generation of 1750A assembly instructions. The Tartan implementation of package MACHINE_CODE is similar to that described in section 13.8 of the Ada LRM, with several added features. Refer to appendix A of this manual for the specification for package MACHINE_CODE.

5.10.1. Basic Information

As required by LRM, Section 13.8, a routine which contains machine code inserts may not have any other kind of statement, and may not contain an exception handler. The only allowed declarative item is a use clause. Comments and pragmas are allowed as usual.

5.10.2. Instructions

A machine code insert has the form `TYPE_MARK' RECORD_AGGREGATE`, where the type must be one of the records defined in package MACHINE_CODE. Package MACHINE_CODE defines three types of records. Each has an opcode and zero, one or two operands. These records allow for the expression of the entire 1750A Assembly language.

5.10.3. Operands and Address Modes

An operand consists of a record aggregate which contains the information needed to specify the corresponding Assembly instruction for generation by the compiler.

Each operand in a machine code insert must have an *Address_Mode_Name*. The address modes specified in package MACHINE_CODE are sufficient to provide all address modes supported by the 1750A Assembly language.

Package MACHINE_CODE also supplies two additional address modes: `Symbolic_Address` and `Symbolic_Value` which can be used to access Ada objects. `Symbolic_Address` and `Symbolic_Value` are implemented by using the object's name in conjunction with the Ada 'ADDRESS attribute. Any Ada object which has the attribute 'ADDRESS may be used in these two addressing modes. However, `Symbolic_Address` should be used when the operand is a true address such as a branch target, while `Symbolic_Value` should be used when the operand is meant to be a numerical value, such as within Immediate addressing modes.

When an Ada object is used as a *source* operand in an instruction, the compiler generates code which fetches the *value* of the Ada object. When an Ada object is used as the *destination* operand of an instruction, the compiler generates code which uses the *address* of the Ada object as the *destination* for the instruction.

5.10.4. Examples

The Tartan implementation of package MACHINE_CODE makes it possible to specify both simple machine code inserts such as

`Two_Opnds' (LR, (R_am, R0), (R_am, R1))`

or more complex inserts such as

`Two_Opnds' (AIM, (R_am, R0), (Symbolic_Address, Array_Var(X, Y, 27)'ADDRESS))`

In the first example, the compiler emits the instruction `LR R0, R1`. In the second example, the compiler first emits whatever instructions are needed to form the address of `Array_Var(X, Y, 27)` and then emits the `AIM` instruction. The various error checks specified in the LRM will be performed on all compiler-generated code unless they are suppressed by the programmer (either through pragma `SUPPRESS`, or through command line switches).

5.10.5. Incorrect Operands

Three modes of operation are supplied for package `MACHINE_CODE`: `/FIXUP=NONE`, `/FIXUP=WARN`, and `/FIXUP=QUIET`.

In `/FIXUP=NONE` mode, the compiler does not attempt to fix any mistakes that the programmer may have made in writing machine code inserts. The compiler simply issues error messages to flag the illegal code and creates a corresponding listing file. The most common errors are illegal register and addressing mode uses in the operand field of the array aggregate.

In `/FIXUP=QUIET` mode, if incorrect addressing modes are chosen by the user in the array aggregates operand field, in most cases the compiler will be able to emit code that corrects the mistake by adding extra instructions or modifying the given instructions to create correct assembly code.

For example, although it is illegal to use a memory address as the source operand for an `AR` instruction, in `FIXUP=QUIET` mode the compiler generates semantically correct code which tries to create the desired effect by adding new instructions in which user code

```
Two_Opnds' (AR, (R_am, R3), (D_am, OBJECT' ADDRESS));
```

Produced output:

```
L      R0, OBJECTADDRESS
AR    R3, R0
```

No warnings are issued to inform the user that substitutions have been made or that `R0` has been used.

Another example is the use of address mode "Direct" which requires a type `system.address`. When the user specifies a register, the following user code

```
Two_Opnds' (A, (R_am, R1), (R_am, R2));
```

produces output:

```
STB    R14, 0
A      R1, 0, R14
```

Here the value of register `R2` has been stored onto the program stack and then referenced as a memory location, which satisfies the requirement that an address be used as the source operand for the `ADD` instruction.

In `/FIXUP=Warn` mode, the compiler does its best to fix any incorrect operands for an instruction but also issues a warning message stating that the machine code insert required additional machine instructions to satisfy the 1750 Assembly language requirements.

5.10.6. Register Usage

Since the compiler may need to allocate registers as temporary storage in machine code routines, there are some restrictions placed on register usage; the compiler automatically frees all of the registers which are volatile across calls for your use (that is, `R0`, `R1`, `R2`, `R3`). In most instances if you reference any other registers, the compiler reserves them for your use until the end of the machine code routine. However, bear in mind that the compiler does *not* save the registers automatically if the routine is inline expanded. This means that the first reference to a register which is not volatile across calls should be an instruction which saves the register's contents to insure that the value is not overwritten and can later be restored at the end of the routine (by the user). This rule will help ensure correct operation of your machine code inserts even if it is inline expanded by another routine (and possibly another user).

As a result of freeing all volatile registers for the user, any parameters which were passed in registers are moved to either a non volatile register or to memory. References to `Parameter'Address` in machine code inserts will then produce code that access these register or memory locations. This means that there is a possibility of invalidating the value of some 'Address expressions if the non volatile register to which the value is bound, is referenced as a destination in some later machine code insert. In this case, any subsequent references to the 'Address expression will cause the compiler to issue a warning message to this effect. In `/FIXUP` mode the compiler uses registers to effect the fixup. If you use all fifteen registers, fixups will not be possible. In general, when more registers are available to the compiler it is better able to generate efficient code.

5.10.7. *Inline Expansion*

Routines which contain machine code inserts may be inline expanded into the bodies of other routines. This may happen under programmer control through the use of pragma **INLINE**, or at Optimization Level 3 when the compiler selects that optimization as an appropriate action for the given situation. The compiler will treat the machine code insert as though it was a call; volatile registers will be saved and restored around the inline expansion as would be done for a call.

5.10.8. *Unsafe Assumptions*

The following assumptions should *not* be made when writing machine code inserts. Violation of these assumptions may result in the generation of code which does not assemble or code that does not produce expected results.

- Do not assume that a machine code insert routine has its own set of local registers, for if the routine is inline expanded into another routine the local registers might not have been saved. Explicitly save and restore any registers which are not volatile across calls, that is, any register *other* than R0, R1, R2, or R3.
- If you wish to guarantee that a routine will never be inline expanded, you should use an Ada separate body for the routine and make sure that there is no pragma **INLINE** for it.
- Do not attempt to move multiple Ada objects with a single instruction such as **MOV** . Although the objects may be contiguous under the current circumstances, there is no guarantee that later changes will permit them to remain contiguous. If the objects are parameters, it is virtually certain that they will not be contiguous if the routine is inline expanded into the body of another routine. In the case of locals, globals, and own variables, the compiler does not guarantee that objects which are declared textually "next" to each other will be contiguous in memory. If the source code is changed such that it declares additional objects, this may change the storage allocation so that objects which were previously adjacent are no longer adjacent.
- The compiler *will not* automatically generate call site code for you if you emit a call instruction, if you emit a call, *you are also expected to emit the linkage conventions of the routine you are calling*. If the routine you call has out parameters, a large function return result, or an unconstrained result, it is the responsibility of the *programmer* to emit the necessary instructions to deal with these constructs in a manner that is consistent with the calling conventions of the compiler.
- It should not always be assumed that the '**ADDRESS**' attribute will produce an operable **ADDRESS**. Whether the attribute is used as an address or a value will be determined by the address mode chosen, (**Symbolic_Address** or **Symbolic_Value**).
- The compiler will not prevent you from writing register R1, which is used to hold the address of the current exception handler. This provides you the opportunity to make a custom exception handler. However, be aware that there may be considerable danger in doing so. Details of the exception handling convention can be found in *Tartan Ada Runtime Implementor's Guide*.

5.10.9. *Limitations*

The current implementation of the compiler is unable to fully support automatic fixup of certain kinds of operands. In particular, the compiler assumes that the size of a data object is the same as the number of bits which is operated on by the instruction chosen in the machine code insert.

Note that the use of **X'ADDRESS** in a machine code insert *does not* guarantee that X will be bound to memory. This is a result of the use of '**ADDRESS**' to provide a "typeless" method for naming Ada objects in machine code inserts. For example, it is legal to say (**Symbolic_Value**, **X'ADDRESS**) in an insert even when X is found in a register.